User Manual

CANgine

FMS

Edition 10 / November 2007
FW version 6.4 and above

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Version History

Edition	Date	State
10	Nov 2007	Sprinter Flag for Daimler Sprinter is introduced. If the flag is set with the SP1 command, the cycle time for FMS message EngineSpeed is modified to 1000 ms instead of 20 ms as defined in FMS standard. Daimler promised to fix the bug in spring 2008. (Firmware Version 6.5)
9	Nov 2006	I command to set identifier string added (Firmware Version 6.3)
8	Sep 2007	Data Request Mode implemented (Firmware Version 6.1)
7	Jun 2006	Bus FMS implemented (Firmware Version 6.0)
6	Apr 2006	CycleTimeUnit implemented; change behaviour of green RUN LED
5	Dec 2005	Corrections, clarifications and adaptation to firmware 5.0
4	May 2005	Hint to SAE J1939
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Related Documents

SAE J1939 / 71	Vehicle Application Layer	Clarification of FMS data

Notation of special characters

[CR] Enter key or character code carriage return (0x0D)
[LF] character code linefeed (0x0A)
[BELL] character code bell (0x07)

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1. Introduction

Thank you for choosing a product of our CANgine product family. The CANgine family is based on high performance 8 bit microcontrollers with integrated full CAN interface and flash memory. With these controllers we are able to build extremely small but powerful CAN units.

CANgine FMS is powered via the CAN connector. The serial link 'speaks' pure ASCII code. Therefore CANgine FMS can be used on nearly any device with a serial link to which you have access. So the connection to CAN bus is possible for nearly all automation devices even for older ones.

In its standard case, CANgine FMS only measures 53 x 34 x 16 mm³ (2.08 x 1.34 x 0.63 inch³). If this does not fit for some applications CANgine FMS can be delivered in other cases or without case in customer specific variants. Due to the modular concept of CANgine in hardware and firmware this is possible even at lower production volumes. Email or call our sales department if you have special requirements.

The serial link of CANgine FMS supports baud rates from 2.400 up to 115.200 bps. The CAN baud rate is fixed to 250 kbps as defined by the FMS standard. Setting into operation and troubleshooting is made easy due to the two LEDs.

Updating CANgine's software or loading custom specific implementations is easy and can be done without opening CANgine's case.

2. FMS Protcol Types

Startign with firmware 6.0 CANgine FMS supports both FMS protocol variants: Truck FMS (the older one) and Bus FMS (the newer one). Bus FMS differs in a few CAN bus messages and defines some new CAN messages related to busses. The table shows the differences between the two protocol types. Details are outlines in chapter 5.10 where the M command to mask the output variables is described.

Nachricht	Truck-FMS	Bus-FMS
CCVS	ParkingBrake not defined	PTOState not defined
VehicleWeight	CAN message defined	CAN message not defined
ServiceDistance	CAN message defined	CAN message not defined
AMB	CAN message not defined	CAN message defined
DC1	CAN message not defined	CAN message defined
DC2	CAN message not defined	CAN message defined
TD	CAN message not defined	CAN message defined
AIR1	CAN message not defined	CAN message defined
AS	CAN message not defined	CAN message defined
ETC2	CAN message not defined	CAN message defined
ASC4	CAN message not defined	CAN message defined

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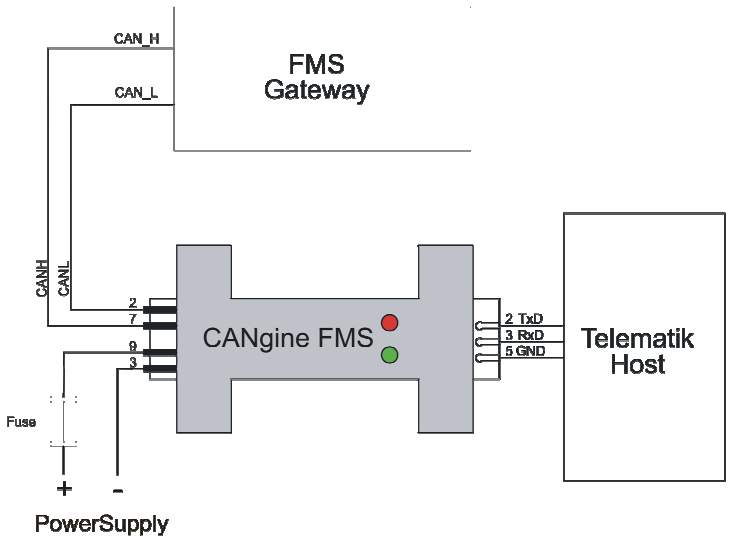
3. Installation

The picture shows how to connect CANgine FMS to a CAN / FMS Gateway. Power supply is connected via pin 9 and pin 3 of the CAN connector as proposed by CiA[1]. The maximum supply voltage is 30 V. Applying higher voltages will lead to damages. If you are not sure of the need for a terminating resistor of 120 Ohm in your installation ask your truck service partner.



After applying the supply voltage the green LED blinks. The blinking code shows the baud rate of the serial link:

Pulses	Baudrate
2	115200
3	57600
4	38400
5	19200
6	9600
7	4800
8	2400

With the factory default settings (AS = 0) CANgine FMS is now waiting for either the key 's' or the enter key [CR]. If 's' is received the CAN bus is initialized and the output of FMS data to the serial link is started. If [CR] is received CANgine FMS switches to configuration mode.

The serial link of CANgine's host should have the following setting:

- baud rate as indicated by CANgine FMS (see table above)
- 8 data bits
- no parity
- 1 stop bit
- no handshake

[1] CANinAutomation (www.can-cia.org)

4. Initializing procedure

On power on some internal checks are run to guarantee a good operation of CANgine FMS. One of these is checking the EEPROM parameter contents with a checksum. To visualize these checks the red LED is switched on immediately after applying power. If all checks are run successfully the red LED is switched off. If a checksum failure in internal EEPROM is detected, the red LED blinks with a code of four.

Pulses	Failure
4	Checksum failure or memory failure parameter data

If a failure in the parameter data area is detected the default parameters are loaded. The failure is signalized by the blinking error LED until error information is read with the F command.

If the internal checks are completed successfully the peripheral devices (RS232 and CAN) are initialized and the red LED is switched off. The green LED blinks with a blinking code signaling the serial baud rate (see table above). Now CANgine FMS is waiting for either the 'S' or the enter key. No other input is accepted at this point. Key 'S' (without following [CR]) starts CANgine FMS data output, key enter (single CR) feeds to the configuration mode.

- Either key stops blinking the green LED, which from now on signals the operating state: 'Flashig' (900 ms off, 100 ms on) means CAN is opened, FMS messages are decoded and messages are send to the serial link,
- 'Blinking' (500 ms off, 500 ms on) means CANgine FMS is in configuration mode.

If parameter autostart is set (AS = 1) CANgine FMS starts immediately after power on checks with data output to the serial link with the last parameterized baud rate if cycleTime unequal zero. If cycleTime equals zero CANgine FMS waits for the first data request character. All parameters are taken from EEPROM.

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5. Configuration mode

The configuration mode can be entered in two ways:

- From normal operating mode by pressing the key ^s (Ctrl + s) (character code 0x13) (without following [CR])
- After power on with autosart disabled by a single [CR].

When entering the configuration mode CANgine FMS sends the message "[LF]CANgine FMS in configuration mode[CR][LF]" via the serial link and waits for inputs.

In configuration mode the CAN channel is closed and CANgine doesn't generate ACK bits on the CAN bus. The green RUN LED is blinking (500 ms off, 500 ms on).

All parameters entered in configuration mode are immediately stored in non volatile memory and stay active even if power is disconnected. Due to writing the EEPROM configuration commands must not be entered at every start of CANgine FMS.

CANgine FMS works case-insensitive which means 'A' can be replaced by 'a'.

If echo is disabled (E = 0) all commands received via serial link are acknowledged by [CR][LF] or by the string "Illegal command or parameter[CR][LF]". If echo is enabled (E = 1) the whole command string is echoed finished with [CR][LF]. In case of syntax error the command string isn't echoed.

Commands leading to a write to the EEPROM (A, AS, C, CU, D, E, M, S, U) are acknowledged after writing the EEPROM. These commands can cause the message "[BELL]Error writing EEPROM[CR][LF]" if writing the internal EEPROM fails.

Never send a new command to CANgine FMS if you haven't received an positive or negative acknowledge for the last command either by [CR][LF], the command echo or the error message.

5.1 Command overview

?[CR]	Shows configuration parameters
An[CR]	Sets axle count (Parameter AxleCount)
Asn[CR]	Autostart on (n=0) or off (n=1)
Cn[CR]	Sets cycle time for output to serial link (Parameter CycleTime)
Cuc[CR]	Sets cycle time unit to either 'M' (milliseconds) or 'S' (seconds)
Dc[CR]	Sets decimal separator for output to serial link (Parameter DecChar)
En[CR]	Echo off (n=0) or on (n=1)
F[CR]	Outputs error information
Istring[CR]	Sets the string to be sent in front of CANgine's serial output
Mcccc[CR]	Sets mask to define the output values (Parameter OutMask)
Pc[CR]	Sets protocol to Truck FMS (c=T) or Bus FMS (c=B)
R[CR]	Restart from configuration mode
Sn[CR]	Sets output to screen or table format (Parameter ScreenForm)
SPn[CR]	Sets or resets 'Sprinter watchdog time' for EngineSpeed message
Un[CR]	Sets RS232 baud rate (Parameter UartBaud)
V[CR]	Outputs version information

5.2 ? command – show parameters

Displays the actual parameter setting

Format:
?[CR]
Answer:
Parameter set
Error message on wrong command format

Output format (default factory settings):

```
A  (AxleCount)         3
AS (Autostart)         Off
C  (CycleTime)         1000
CU (CycleTimeUnit)     M (msec)
D  (DecimalSeperator)  ,
E  (Echo)              Off
I  (ID string)         not defined
M  (MaskForOutput)     1FFF
P  (Protocol)          T
S  (ScreenFormat)      1
SP (Sprinter Bug Fix)  0
```

5.3 A Command - axleCount

Sets the count of axles used for the output format of FMS message Weight in truck protocol. Standard value is 3. If CANgine is in Bus protocol mode, this parameter is meaningless.

Format:
An[CR]
n = {1..16}
Answer:
[CR][LF], if value is accepted
Error message on wrong parameter value or command format

5.4 AS Command – autostart

In the default factory setting (AS = 0) CANgine FMS expects a [CR] or the character 'S' after applying power. Receiving [CR] CANgine FMS switches to configuration mode, receiving the character 'S' CANgine FMS switches to normal operating mode. If the parameter autostart is set by AS = 1, CANgine FMS enters normal operating mode immediately after applying power: The message "[LF]CANgine FMS in normal operation mode[CR][LF]" is send to serial link, followed by the first data output (see chapter 6.6.1).

Format:
ASn[CR]
n = {0 | 1}
Answer:
[CR][LF] if parameter is accepted
Error message on wrong parameter value or command format

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5.5 C Command – cycleTime

The C command sets the cycle time of the output to the serial link. Accepted values are zero or between 100 and 60,000. The cycle time is internally calculated from the value given with C command and the unit given with CU command. If the cycle time is to short for output of all values (selected with M command) with the given UART baud rate, error bit 0 is set with the next serial output and the red LED signals cycle overrun (see chapter 6.8.1 for details).

Format:

Cn[CR]

N = {0 | 100..60000}

Answer:

[CR][LF] if parameter is accepted
Error message on wrong parameter value or command format
'Cycle time too short, set to 100 ms!' if the time is unequal 0 and less than 100 ms.

5.6 CU Command – cycleTimeUnit

The CU command sets the cycle time unit of the output to the serial link either to milliseconds ('M') or seconds ('S'). If the resutling cycle time is less than 100 ms the minimum value of 100 ms is set automatically. In this case an output message is generated.

Format:

CUc[CR]

c = {'M' | 'm' | 'S' | 's'}

Answer:

[CR][LF] if parameter is accepted
Error message on wrong parameter value or command format
'Cycle time too short, set to 100 ms!' if the time is less than 100 ms.

5.7 D Command – decimal separator

Define the separator character for numeric values used in the output strings. This is helpful if table output is used and data is needed for table calculations. You can either choose ',' (comma) or '.' (dot).

Format:

Dc[CR], with c = . or c = ,

Answer:

[CR][LF] if parameter is accepted
Error message on wrong parameter value or command format

5.8 E Command – echo on or off

CANgine FMS supports the possibility to get the received command string echoed. The echo is send after the command is executed successfully which means after writing the EEPROM.

One exception is the answer to the U command (changing serial baud rate), which is echoed before the baud rate is switched and the new parameter is stored. The host control is responsible to wait about 200 ms after an acknowledged U command before sending a new command with the changed baud rate.

Format:

En[CR], with n = {0 | 1}

Answer:
[CR][LF] if parameter is accepted and echo is switched from on (1) to off (0)
E1[CR][LF] if parameter is accepted and echo is switched from off (0) to on (1)
Error message on wrong parameter value or wrong command format

5.9 F Command – error information

Read and reset the internal error register.

Format:
F[CR]
Answer:
Fxx[CR][LF]
Error message on wrong command format

xx is a two digit hexadecimal code with the following bit meanings

7	6	5	4	3	2	1	0
res	checksum failure EEPROM	res	res	CAN Bus Off	CAN error passive	res	Output cycle time too short

An internal error is also signaled by the red LED with blinking codes (see 5.4). The red LED is switched off and the error information reset to zero when error information is read and the error reason is gone.

If the error is CAN Bus Off, the CAN controller is re-initialized on reading the error information.

5.10 I Command – Identifier String

With the I command a string can be defined which is always sent in front of the serial output. The string is stored in non-volatile memory. To delete the string I[CR] must be entered. If the string is deleted, the field in front of the time stamp is omitted. This is due to compatibility reasons to older firmware versions. The string can contain any special characters excluding ';' which is used as field seperator in S0 output format. Be aware of confusing serial output if you enter control characters inside the identifier string. If in doubt delete the string using "I[CR]" and enter it again.

Format:
Istring[CR]
string is an alphanumeric string with zero or up to twenty characters
Answer:
[CR][LF] if string is stored
Error message on wrong command format, illegal string length or illegal characters in string

5.11 M Command – mask for output values

The M command sets the mask for the FMS messages involved in output values. Acceptable parameter range is between 1 and 1FFEEF. Value has to be input in hexadecimal notation:

Format:
Mcccccc[CR] with cccccc = mask register (max. 6 hexadecimal digits)

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Answer:
[CR][LF] if value is accepted
Error message on wrong parameter value or command format

In the mask register the bits related to the desired output messages has to be set to '1'. If a value should not appear in the output the related bit has to be set to '0'. The table shows the bit positions and the related messages for the both protocols Truck and Bus.

Bit	7	6	5	4	3	2	1	0
Truck	Fuel Consumption	Engine Hours	Vehicle Distance	Service Distance	CCVS	TCO	Accelerator Pedal	Engine Speed
Bus	Fuel Consumption	Engine Hours	Vehicle Distance	not defined[1)]	CCVS	TCO	Accelerator Pedal	Engine Speed

Bit	15	14	13	12	11	10	9	8
Truck	re-served[1)]	not defined[1)]	not defined[1)]	FMS Version	Vehicle ID	Fuel Level	Engine Temp.	Vehicle Weight
Bus	Door Control2	Door Control1	Transmission Control	FMS Version	Vehicle ID	Fuel Level	Engine Temp.	not defined[1)]

Bit	20	19	18	17	16
Truck	not defined[1)]	not defined[1)]	not defined[1)]	not defined[1)]	not defined[1)]
Bus	Ambient Temp	Time Date	Alternator Speed	Air Supply	Air Suspension

[1)] 'reserved' and 'not defined' bits has to be set to '0'

When CANgine is in Truck protcol mode (P=T) with M1FFF all messages are enabled for output. When CANgine is in Bus protocol mode (P=B) with M1FFEEF all messahes are enabled for output.

5.12 P Command – select protocol

The P command selcts either the Truck or the Bus protocol. The protocol selected affects the output of the CCVS message values (see chapter x). When the protocol is switched with the P command, the mask register is set to a default value related to the protocol:

- 1FFF if Truck protocol is selected,
- 1FFEEF if Bus protocol is selected.

Format:
Pc[CR]
C 0 {b | B | t |T}
Answer:
[CR][LF] if command is accepted
Error message on wrong parameter value or command format

5.13 R Command - restart

Ends the configuration mode and restarts CAN bus and output to serial link. After a successful start the green RUN LED starts to flash (900 ms off, 100 ms on).

Format:
R[CR]

Answer:

Message "[LF]CANgine FMS in normal operation mode[CR][LF]" immediately followed by the first data output (see chapter 6.6.1 or **Fehler! Verweisquelle konnte nicht gefunden werden.**).
Error message on wrong command format

5.14 S Command – screen format

The S command sets the format of the serial output.

S0 sets the spreadsheet format for output. All values are separated by the ';' character and are output in one line beginning with the time stamp. For details see chapter x.

S1 sets readable format where each FMS message is output on an own line and each value is preceded by its name and followed by its unit if applicable. For details see chapter x.

Format:

Sn[CR]

n = {0|1}

Answer:

[CR][LF] if command is accepted
Error message on wrong parameter value or command format

5.15 SP Command – Set / Reset Sprinter Flag

In the default factory setting (SP = 0) CANgine FMS assumes the cycle time of the EngineSpeed message to be 20 ms as described in the FMS standard. Daimler's Sprinters build in 2007 and early 2008 supporting FMS delivers the EngineSpeed message with a cycle time of 1000 ms. As CANgine FMS surveys the cycle times to detect malfunction of CAN FMS busses it leads to malfunction if a CANgine FMS is connected to a Daimler Sprinter build in 2007 and early 2008.

Setting the Sprinter flag helps in such cases to avoid '*' characters in the serial data stream instead of the actual engine speed value. But you have to be aware that the engine speed value is 1 second old if you receive it.

SP0 resets the value to 20 ms.

Format:

SPn[CR]

n = {0 | 1}

Answer:

[CR][LF] if parameter is accepted
Error message on wrong parameter value or command format

5.16 U Command – uart baudrate

The U command sets the baud rate of the serial link. The answer is given with the old baud rate and if command is accepted the baud rate is switched immediately after the answer output.

Command	bps
U1	115200
U2	57600
U3	38400

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U4	19200
U5	9600
U6	4800
U7	2400

Format:
Un[CR]
Answer:
[CR][LF] command successfull
Error message on wrong parameter value or command format

5.17 V Command – version information

The V command results in version information for hardware and software

Format:
V[CR]
Answer:
Vhhss[CR][LF]
with hh = hardware version and ss = software version
Error message on wrong command format

6. Operating mode

In normal operating mode the CAN channel is active, the received FMS messages are interpreted and the received values are stored in an internal process image. ASCII output for the serial link is built up and send either in a cycle given by the parameter CycleTime and CycleTimeUnit or if the data request character is received (if cycleTime equals zero). Output is given in the format defined by the parameter ScreenFormat. Only messages marked with a 1 Bit in the parameter MaskForOutput are included.

6.1 Cyclic operation

Cyclic operation is achieved by setting cycle time unequal from zero with the 'C' command (see chapters 5.5 and 5.6). In the cyclic operation mode the data output is started when CANgine enters normal operating mode. When starting output a timer is also started with the parameterized cycle time. When this timer is expired the next output is started. If the time for data output is longer than the parameterized cycle time the error 'Output cycle Time Too Short' is signaled.

6.2 Data Request Operation

Data request operating mode is achieved by setting the cycle time to zero. In this case no data output is generated until the 'data request character' (P) is received. When this character is received, the data output is build up from the process image and send to the serial link. The data request character can be sent immediately after entering normal operation mode. After sending the data request character a latency time is needed in which error conditions are checked and the data output is build up.

As in cyclic operation the data request character must not be sent in shorter cycles than the serial data output needs due to the parameterized output variables and baud rate. If this happens the 'data output cycle too short' error is signaled.

6.3 Watchdog for FMS messages

If any parameter is missed because no FMS message was yet available the character '*' is output instead of the value. All FMS messages are monitored by a watchdog timer which is set to 1.5 times the cycle time defined in the FMS standard (see table in chapter 6.5). If a FMS message is missed too long '*' characters are output instead of the last received values.

The watchdog timer for the axle weight messages is a little bit more sophisticated. As the cycle time depends on the number of axles, the time is set according to the parameter AxleCount (command A). If the parameterized number of axles is less than the real number of axles on the vehicle the calculated watchdog time is too short. This setting results in the occasional output of '*'.

For the special case CANgine FMS is working in a Daimler Sprinter build in 2007 and early 2008 there is a special parameter to modify the watchdog for the EngineSpeed message from 20 ms to 1000 ms. With the SP1 command the watchdog time is set to 1000 ms. The factory default setting is SP0 with cycle time set to 20 ms.

6.4 Value ranges

SAE J1939-71 defines for every variable an allowed range and ranges with the meanings

- out of range

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- error indicator
- not available (at actual time or in the truck)

If such a value is received on the FMS bus the following characters are output instead of numerical values:

- 'o' for out of range
- 'e' for error
- 'n' for not available

6.5 FMS messages, mask bits and FMS cycle times

Message	Cycle Time [ms]	Mask Bit	Mask Value [hex]	Truck FMS	Bus FMS
Engine speed	20[1]	0	0x00'0001	yes	yes
Accelerator Pedal	50	1	0x00'0002	yes	yes
TCO	50	2	0x00'0004	yes	yes
CCVS	100	3	0x00'0008	yes	yes
Service Distance	1.000	4	0x00'0010	yes	no
Vehicle Distance	1.000	5	0x00'0020	yes	yes
Engine Hours	1.000	6	0x00'0040	yes	yes
Fuel Consumption	1.000	7	0x00'0080	yes	yes
Vehicle Weight	1.000	8	0x00'0100	yes	no
Engine Temperature	1.000	9	0x00'0200	yes	yes
Fuel Level	1.000	10	0x00'0400	yes	yes
Vehicle ID	10.000	11	0x00'0800	yes	yes
FMS Version	10.000	12	0x00'1000	yes	yes
TransmissionControl	100	13	0x00'2000	no	yes
DoorControl1	100	14	0x00'4000	no	yes
DoorControl2	100	15	0x00'8000	no	yes
AirSuspension	100	16	0x01'0000	no	yes
AirSupply	1.000	17	0x02'0000	no	yes
AlternatorSpeed	1.000	18	0x04'0000	no	yes
TimeDate	1.000	19	0x08'0000	no	yes
AmbTemp	1.000	20	0x10'0000	no	yes

Default factory setting for the mask bits is 1FFF when Truck protocol is selected and 1FFEEF when Bus protcol is selected which means that all messages are included in output.

6.6 Output Formats

Output can be formatted in two ways. The following chapters explain the formats and the variables.

6.6.1 Screen format (S = 1)

With parameter s set to 1 a readable 'screen format' with variable names and physical units is selected. See below the outputs for the default masks in Truck protocol mode and in Bus protocol mode.

[1] see chapter 5.15 for special treatement

6.6.1.1 Truck FMS Protocol

```
IdentifierString
0-00:11:56.961
EngSpeed 2725,125 rpm
Accel    51,2 %
TCO      78,12 km/h MD:1  OS:0  DI:0  TP:0  HI:0  EV:0  D1:1/3/1 D2:0/2/7
Speed    78,12 km/h CC:1 BR:0 CS:0 PTO:1
Service  +3205 km
Distance 45342,125 km
EngHours 975,05 h
FuelC    9839,0 L
Weight   1000,0 kg (n) 2000,0 kg (n) 3000,0 kg (n)
EngTemp  +71 degr
FuelLev  60,4 %
VehID    CANgine
FMS      01.00 Diag:0 Requ:0
```

6.6.1.2 Bus FMS Protocol

```
IdentifierString
0-00:22:15.273
EngSpeed 2725,125 rpm
Accel    51,2 %
TCO      78,12 km/h MD:1  OS:0  DI:0  TP:0  HI:0  EV:0  D1:1/3/1 D2:0/2/7
Speed    78,12 km/h CC:1 BR:0 CS:0 PB:0
Distance 45342,125 km
EngHours 975,05 h
FuelC    9839,0 L
EngTemp  +71 degr
FuelLev  60,4 %
VehID    CANgine
FMS      01.01 Diag:0 Requ:0
Gear     S:5 C:5
DoorCtr1 P:2 R:0 S:0
DC2 loe  1:100 2:100 3:100 4:100 5:nnn 6:nnn 7:nnn 8:nnn 9:nnn 10:nnn
BellowPr FAL:2109,8 kPa FAR:2234,5 kPa RAL:2345,6 kPa RAR:2456,7 kPa
BrakePr  1:1984 kPa 2:1872 kPa
Alternat 1:1 2:1 3:n 4:n
DateTime 2006.07.06-14:45:16
AmbTemp  31,8 degr
```

6.6.2 Spreadsheet Format (S = 0)

With parameter s set to 0 a reduced spreadsheet format without any variable names and units is selcted. All numerical values are separated by the ';' character. One line holds all values selected with the mask command. As done in the screen format all variables with special meaning or not available are marked with the characters 'n', 'e', 'o' or '*'. The line is terminated by the characters [CR][LF].

6.6.2.1 Truck FMS Protocol

```
IdentifierString;0-00:13:18.114;2725,125;51,2;78,12;1;0;0;0;0;0;1;3;1;0;2;7;78,12;
1;0;0;1;+3205;45342,125;975,05;9839,0;1000,0;n;2000,0;n;3000,0;n;+71;60,4;CANgine;
01.00;0;0;
```

The 37 column names (3 axles; with n axles 31 + n x 2) are shown below. If an axle count other than 3 is parametrized and/or a mask other than 1FFF is set the related column names must be added or discarded. If the 'I' command was used to parameterize an identifier string, the identifier string is sent in front of every serial output. In this case the standard truck output has 38 fields. If the 'I' command was never used or used with an empty string, the identifier-String field is omitted completely.

```
IdentifierString;Time;EngSpeed;Accel;TCO_Speed;TCO_MD;TCO_OS;TCO_DI;TCO_DP;TCO_HI;
```

```
TCO_EV;TCO_D1_PR; TCO_D1_WS;TCO_D1_TS;TCO_D2_PR;TCO_D2_WS;TCO_D2_TS;VehSpeed;CC;BR;
CS;PTO;Service;Distance;EngHours;FuelC;Weight_A1;T_A1;Weight_A2;T_A2;Weight_A3;
T_A3;EngTemp;FuelLev;VehID;FMS_Versd;FMS_Diag;FMS_Requ;
```

6.6.2.2 Bus Protocol

```
IdentifierString;0-00:24:05.862;2725,125;51,2;78,12;1;0;0;0;0;0;1;3;1;0;2;7;78,12;
1;0;0;0;45342,125;975,05;9839,0;+71;60,4;CANgine;01.01;0;0;5;5;2;0;0;100;100;100;
100;nnn;nnn;nnn;nnn;nnn;nnn;2109,8;2234,5;2345,6;2456,7;1984;1872;1;1;n;n;
2006.07.06-14:45:16;31,8;
```

The 57 column names are shown below. If a mask other than 1FFEEF is set the related column names must be added or discarded. If the 'I' command was used to parameterize an identifier string, the identifier string is sent in front of every serial output. In this case the standard truck output has 58 fields. If the 'I' command was never used or used with an empty string, the identifierString field is omitted completely.

```
IdentifierString;Time;EngSpeed;Accel;TCO_Speed;TCO_MD;TCO_OS;TCO_DI;TCO_DP;TCO_HI;
TCO_EV;TCO_D1_PR;TCO_D1_WS;TCO_D1_TS;TCO_D2_PR;TCO_D2_WS;TCO_D2_TS;VehSpeed;CC;BR;
CS;PB;Distance;EngHours;FuelC;EngTemp;FuelLev;VehID;FMS_Versd;FMS_Diag;FMS_Requ;
Gear_S;Gear_C;DC1_P;DC1_R;DC1_S;DC2_1;DC2_2;DC2_3;DC2_4;DC2_5;DC2_6;DC2_7;DC2_8;
DC2_9;DC2_10;BellowPr_FAL;BellowPr_FAR;BellowPr_RAL;BellowPr_RAR;BrakePR_1;
BrakePr_2;Altern_1;Altern_2;Altern_3;Altern_4;DateTime;AmbTemp;
```

6.7 Output Values

6.7.1 Identifier string – optional output field

The identifier string output field is an optional output field. It was introduced starting with firmware version 6.3. If no identifier string is parameterized the field is omitted. The string is a user definable alphanumerical string with up to twenty characters. The string can be entered using the 'I' command.

6.7.2 Time – internal time information

The first line gives the time information in the format d-hh:mm:ss.ms. Milliseconds are given with three digits. Time measuring starts with 0-00:00:00.0 on powering up CANgine FMS. Information for the day is incremented every 24 hours by one until 65535.

6.7.3 EngSpeed – engine speed

The second line shows the engine speed. Unit is rpm (rotations per minute), resolution is 0.125 rpm.

If you detect any problems reading the engine speed in a Daimler Sprinter please read chapter 5.15 to find solutions to avoid this problem.

6.7.4 Acc – accelerator pedal position

The third line shows the accelerator pedal position in % with a resolution of 0.4%.

6.7.5 TCO – tachograph information

Line 4 contains the information given by the tachograph. The first value is the speed information in km/h with a resolution of 1/256 km/h. The other information are:

sign	Value	meaning
MD	0 or 1	motion detected (1: yes, 0: no)
OS	0 or 1	overspeed detected (1: yes, 0: no)

sign	Value	meaning
DI	0 or 1	direction (0: forward, 1: reverse)
TP	0 or 1	tachograph performance (1: analyze, 0: normal)
HI	0 or 1	handling information (1: yes, 0: no)
EV	0 or 1	tachograph event (1: yes, 0: no)
D1	0 or 1	driver 1 information (1: present, 0: absent)
	0..5	working state (see table below)
	0..13	time state (see table below)
D2		driver 2 information (same as driver 1)

Working state	
0	Rest
1	Available
2	Work
3	Drive
4..5	res.

Time state	
0	Normal
1	15 min. bef. 4 ½ hours
2	4 ½ hours reached
3	15 min. bef. 9 hours
4	9 hours reached
5	15 min. bef. 16 hours
6	16 hours reached
7..13	res.

6.7.6 Speed – wheel based speed

The line marked with speed shows the wheel based speed in km/h with a resolution of 1/256 km/h. It also shows information about clutch switch (CS), brake switch (BR) and cruise control (CC). For CS, BR and CC 0 means not pressed or inactive, 1 means pressed or active.

If the Truck protocol is active (P=T) the state of the Power Take Off device (PTO) is also given. Concerning PTO state the FMS standard defines only the values 0 (off/disabled), 5 (set) and 31 (not available). CANgine FMS interprets the received values according SAE J1939-71 and output values between 0 and 19 as numerical values if the truck supports it. For values between 10 and 30 CANgine FMS outputs 'o' and for the value 31 'n'.

If the Bus protocol is active (P=B) the state of the parking brake is displayed instead of the PTO device. 0 means parking brake open, 1 means parking brake set.

6.7.7 Service – service distance

Service shows the service distance in km with a resolution of 5 km. The range is between -160635 and +160640 km. The service message is only supported in Truck FMS protcol.

6.7.8 Distance - vehicle distance

Distance shows the total vehicle distance in km with a resolution of 5 m.

6.7.9 EngHours - engine time

EngHours shows the total engine time in hours with a resolution of 0.05 h.

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6.7.10 FuelC - fuel consumption

FuelC gives the accumulated fuel consumption in l (liter) with a resolution of 0.5 l.

6.7.11 Weight

The line 'Weight' gives the axle weights with the number of wheels per axle. The information is given for the number of axles defined in parameter 'axle count'. The axles are given in the order front to back. The weight is in kg with a resolution of 0.5 kg. Most truck manufacturers do not support the number of wheels. In these trucks CANgine outputs 'n' (not supported). Axle weight messages are only supported with Truck protocol.

6.7.12 EngTemp - cooloing temperature

EngTemp gives the engine coolant temperature in degree Celsius with a resolution of 1 degree.

6.7.13 FuelL - fuel level

FuelL shows the fuel level in % with a resolution of 0.4%.

6.7.14 VehID - vehicle ID

VehId shows the identification string of the vehicle. According to SAE J1939-71 ASCII strings are terminated by the character '*'. CANgine FMS doesn't output the character '*'.

6.7.15 FMS – FMS version

This line shows the version of the implemented FMS standard in the form vv.rr where vv is the two digit version number and rr is the two digit revision number.

Diag announces if the FMS implementation supports diagnostic messages, Requ announces if the implementation supports requests.

6.7.16 Gear – transmission information

This information is only supported in Bus protocol. The selected (S) and current (C) gear are shown. Negative values are reverse gears, the value 0 means neutral and a value of 126 means park position.

6.7.17 DoorControl1

DC1 gives an information about the status of the doors. The value after P shows the position state, R is the ramp state and S the overall state (see table).

P (Position)		R (Rampe / Lift)		S (Gesamtstatus)	
0	At least 1 door is open	0	Inside bus	0	All bus doors disabled
1	Closing last door	1	Outside bus	1	At least 1 bus door enabled
2	All doors closed				

6.7.18 DoorControl2

This information is only supported in Bus protocol. The message shows the states of 10 doors. For every door 3 values are given: LockState, OpenState and EnableState (see table).

L (LockState)		
0	unlocked	Door may be operated by the driver or a passenger
1	Locked	Door cannot be operated by the driver or a passenger
O (OpenState)		
0	Closed	Door is completely closed
1	Open	Door is not completely closed
E (EnableState)		
0	Disabled	Door cannot be opened by a passenger
1	enabled	Door can be opened by a passenger

These values are given for every door as a character string with 3 characters in the order LOE. For example

```
DC2 loe  1:100 2:100 3:100 4:100 5:nnn 6:nnn 7:nnn 8:nnn 9:nnn 10:nnn
```

means that 4 doors are present and all 4 doors are 'locked', 'closed' and 'disabled'.

6.7.19 AirSuspension

This information is only supported in Bus protocol. The message supports the air suspension pressure with the 4 bellow pressure values front axle left (FAL), front axle right (FAR, rear axle left (RAR) and rear axle right (RAR). The pressure are given in kPa with a resolution of 0.1 kPa.

6.7.20 AirSupply

This information is only supported in Bus protocol. It gives the air pressure values of the two service brakes. The vaklues are given in kPa with a resolutions of 8 kPa.

6.7.21 Alternator

This message shows the states of up to 4 alternators. A value of '0' means alternator is not charging, '1' means alternator is charging. This information is only supported in Bus protocol.

6.7.22 TimeDate

Information about date and time. The output string is formatted as yyyy.mm.dd-hh:mm:ss where

yyyy 4 digit year number
mm 2 digit month number
tt 2 digit day number
hh 2 digit hour (24 h format)
mm 2 digit minute
ss 2 digit second

This information is only supported in Bus protocol.

6.8 Error handling

The errors given in the table below are handled by CANgine FMS. If one of these errors occurs, a bit in the internal error register is set and the red LED shows a blinking code.

Error	Bit in error register	Blinking code
Output cycle time too short	0	1
CAN in "error passive" mode	2	2
CAN in "bus error" mode	3	3

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6.8.1 Cycle time overflow

Output to the serial link is done in a fixed cycle given by the parameter cycleTime (command C). If cycleTime and the uart baudrate defined by parameter uartBaud don't fit the output to serial link is in progress when the next cycle should start. This is monitored and signaled by the CANgine FMS. If you run in this situation either increase the uart baudrate with the U command or increase the cycle time with the C command.

Reading the error information with the F command resets the error information.

6.8.2 CAN bus errors

If the CAN controller signals one of the states "CAN error passive" or "CAN bus error" there are severe interferences on the CAN bus. Normally this happens if another CAN node tries to drive the bus with a wrong baud rate or the terminating resistors are missing or have wrong values.

Even those error conditions are reset by reading the error information, the error situation may still be present and therefore the error bit is set again immediately after being reset. First remove the source of error before you reset CANgine FMS by reading the error information.

If a "CAN bus off" error is set when reading the error information the CAN controller is completely initialized before CANgine restarts.

7. Implementation Hints

If you write the software for control and handling the CANgine FMS please keep in mind the following hints.

7.1 Configuration

Configuring CANgine FMS according to your environment should be done once before mounting the CANgine FMS in the vehicle. Only if you change your software it could be of interest to change parameters in CANgine FMS but this should be a singular event and not be done cyclic. Every change of a parameter leads to EEPROM writing and EEPROM write cycles are limited. Therefore unchanged parameter must not be written cyclic in the EEPROM.

7.2 Autostart

Preferably configure CANgine FMS to autostart (AS = 1). CANgine FMS will start to output data immediately after power up and after sending the message "[LF]CANgine FMS in normal operation mode [CR][LF]".

7.3 Echo

If you want to see the commands CANgine FMS has received and executed, set parameter Echo to on (E = 1) by sending "E1[CR]". CANgine FMS answers "E1[CR][LF]" and all following commands are positive acknowledged by the received command string terminated with [CR][LF]. Negative acknowledge due to parameter failures or syntax errors is in either case the message "Illegal command or parameter[CR][LF]".

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8. Configuration parameter

Parameter	Command	Range	Default value
AxleCount	A	1 .. 16	3
Autostart	AS	0 or 1	0
CycleTime	C	0, 100 .. 60000	1000
CycleTimeUnit	CU	'M' or 'S'	'M'
DecimalSeparator	D	Comma (,) or Dot (.)	Komma (,)
Echo	E	0 or 1	0
Identifier String	I	0..20 alphanumerical characters	[NUL] [1)]
MaskForOutput	M	0001 .. 1FFF	1FFF
Protocol	P	'T' or 'B'	'T'
ScreenFormat	S	0 or 1	1
SprinterBugFix	SP	0 or 1	0
UartBaud	U	1 .. 7 (115200 .. 2400)	4 (19200)

[1)] means no string is defined and the appropriate output field is omitted

9. Connector pinout

9.1 Serial link

Pin	Signal	Pin	Signal
1	nc	6	nc
2	TxD	7	nc
3	RxD	8	nc
4	nc	9	nc
5	GND		

9.2 CAN

Pin	Signal	Pin	Signal
1	nc	6	GND
2	CANL	7	CANH
3	GND	8	nc
4	nc	9	+Vcc
5	nc		

10. Technical data

Power supply	7 .. 30	VDC
Power consumption	35 (typ.)	mA
Internal micro controller	Internal clock: 40 Full CAN 2.0B interface	MHz
CAN transceiver	82C251	
CAN connector	Sub-D 9 male	
CAN baudrate	250	kBit
Serial link	Sub-D 9 female	
Serial baudrate	2400 .. 115200	bps
Display	LED RUN (green) LED ERR (red)	
Dimensions	53 x 34 x 16 2.08 x 1.34 x 0.63	mm^3 $inch^3$
Weight	26	g
Temperature range	-40 .. +80	℃

11. Changes starting with firmware version 5.0

Also binary value outputs are now in numerical format (e.g. 'y' is replaced by '1' and 'n' is replaced by '0'). The output of alphabetical characters is reserved for

'n' not available (in actual truck or at actual time)
'e' value is faulty
'o' value is out of range
'*' FMS message was not received longer than 1.5 times the defined cycle time

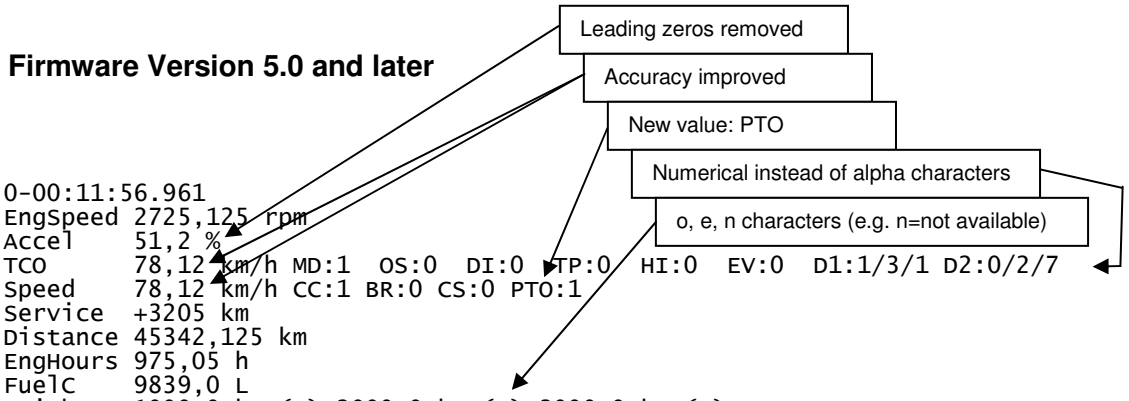
'n', 'e' and 'o' are derived from the FMS variable values and are generated by the trucks ECU's. '*' is calculated by CANgine FMS by monitoring the FMS defined cycle times.

So the serial output of a CANgine FMS version 5.0 differs significant to the serial output of former versions. The example below shows the differences.

Firmware before Version 5.0

```
0-00:00:31.263
EngSpeed 5493,375 rpm
Acc      051,6 %
TCO      101,5 km/h MD y OS y DI r TP a HI y EV y D1:p/3/05 D2:p/7/15
Speed    101,3 km/h CC:1 BR:0 CS:0
Service  -155635 km
Distance 2958755,245 km
EngHours 15270994,80 h
FuelC    152709948,5 L
Weight   10939,5 kg 2 6553,5 kg 4 10922,5 kg 4
EngTemp  +88 degr
FuelLev  068,4 %
VehID    CANgine
FMS      01.00 Diag: n Requ: n
```

Firmware Version 5.0 and later


Leading zeros removed
Accuracy improved
New value: PTO
Numerical instead of alpha characters
o, e, n characters (e.g. n=not available)

```
0-00:11:56.961
EngSpeed 2725,125 rpm
Accel    51,2 %
TCO      78,12 km/h MD:1  OS:0  DI:0  TP:0  HI:0  EV:0  D1:1/3/1 D2:0/2/7
Speed    78,12 km/h CC:1 BR:0 CS:0 PTO:1
Service  +3205 km
Distance 45342,125 km
EngHours 975,05 h
FuelC    9839,0 L
Weight   1000,0 kg (n) 2000,0 kg (n) 3000,0 kg (n)
EngTemp  +71 degr
FuelLev  60,4 %
VehID    CANgine
FMS      01.00 Diag:0 Requ:0
```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